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THE PATHOLOGICAL ANATOMY OF ACUTE ARSENICAL POISONING.*

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IN this communication only those anatomical changes that may be caused by acute arsenical intoxication and are susceptible of demonstration in the fresh cadaver will be considered. While the frequency of poisoning with arsenic is steadily diminishing in certain European cities and countries, this mode of terminating life appears to be quite popular in this city. Of 431 cases of fatal poisoning investigated at the Medico-Legal Institute, in Berlin, during the years 1876, '77 and '78, only eight were instances of arsenical intoxication; of 120 cases of suicide by poisoning examined in Vienna during 1874-'75, only two had selected arsenic. In France, in 1857, arsenic was the poison employed in thirty-five of sixty-three murders by poisoning; in 1860, it was used only three times in thirty-two; in 1862, five times in thirty-eight.† Of forty-seven cases of acute poisoning admitted into the Cook County Hospital‡ in Chicago, during 1890, eight were instances of arsenical poisoning; in fifty-nine cases of poisoning investigated by the coroner of Cook County‖ during the year 1890, thirty-two were due to arsenic. Five of these fifty-seven cases were murders, and two of these by the mixture known as "Rough on Rats," two by arsenic in solution, one by Paris green; in twenty-three out of the twenty-seven suicidal poisonings with arsenic "Rough on Rats" was used. One, and perhaps the principal reason for this astounding frequency of arsenical poisoning here, is undoubtedly the ease with which the poison is obtainable—any child can be sent to a drug or

* Read before the Chicago Medico-Legal Society, October 4, 1891.
† Casper-Simon, Handt. d. Gerichtlichen Medicin 8 ed. 2 Vol. Berlin, 1889.
‡ Mitchell, Cook County Hospital Report. Chicago, 1890.
‖ Hertz, Report of Coroner of Cook County, December, 1891.

presented by the author

grocery store for unlimited quantities of arsenic, in the mixture called "Rough on Rats."

In order to bring before you the anatomical changes of acute arsenic poisoning I shall take the liberty to briefly describe the post-mortem appearances in two or three instances:

CASE I. POISONING WITH "ROUGH ON RATS."

This occurred in a family of four and was due to the sprinkling of "Rough on Rats" upon the corn eaten at the fatal supper. The father died about twelve hours after the poisoning, the mother eighteen, and in both the clinical symptoms were quite classical. The two children recovered.

The *post-mortem* examination was made twenty-four hours after death. The appearances were quite similar in both, hence, only one description is necessary at this time. The external appearances were absolutely negative except that the man's skin was yellowish; the facial expression was not indicative of any special emotion. The peritoneal cavity was empty, the peritoneum normal; the stomach was dilated in both instances, hanging low down. The sub-serous veins were moderately filled with blood; in each case the stomach contained about twenty-four ounces of turbid watery fluid of negative odor. The mucous membrane was rather pale, opaque and somewhat swollen, but in the cardial and pyloric regions were punctiform and linear hemorrhages and extensive areas of capillary hyperæmia. The commencement of the duodenum was quite uniformly red, its mucous membrane swollen; in the entire small intestines the *valvulae conniventes* are voluminous, in the upper part irregular areas, greyish white in color, surrounded by a red border. These areas were due to a false membrane which could be peeled off, leaving a small area of necrosis with much capillary injection and hyperæmia. In the lower part of the ileum was much swelling of the solitary and agminate glands, but no croupous areas. The large intestine, as well as the small, contained fluid contents, greyish, turbid and full of shreds; the follicles were swollen in the upper part of the large intestine.

The shreddy masses in the gastric and intestinal contents contained, microscopically, epithelial cells, round cells, mucus corpuscles, and octahedral crystals of arsenic; in the rectum octahedra were found with ease. The mesenteric glands were larger than usual, they were soft and pale red on the cut surface. The pancreas and spleen seemed normal in both cases. The kidneys were also apparently normal except some capsular adhesions in the man. The liver was about normal in size; on the cut surface the lobules seemed large

but the outlines were indistinct, the color yellowish. The heart was of normal size, in both cases there were sub-endocardial areas of blood extravasation in the left ventricle; the myocardium was pale yellowish gray, it was comparatively flabby and teased specimens show indistinct transverse striæ. The lungs were œdematous, the pleuræ smooth and shining. The brain and its membranes were apparently normal. The pharynx, œsophagus and larynx were unchanged. Chemical examination showed abundant arsenic in the gastric and intestinal contents, in the liver and in the kidneys of both the man and the woman.

To recapitulate: In these two cases solid arsenic in the mixture known as "Rough on Rats" produced in twelve and eighteen hours acute parenchymatous gastritis, acute croupous enteritis with hemorrhages and capillary hyperaemia, acute follicular enteritis, swelling of the mesenteric glands, cloudy swelling of the liver and of the myocardium and sub-endocardial ecchymoses.

CASE II.—ARSENICAL POISONING.

A wealthy family near Maplewood, in this city, was mysteriously poisoned with arsenic in the early summer of 1890, the father and a male servant dying. This is the sensational Kuhn tragedy and mystery. The arsenic, probably in solution, was placed either in the coffee, or in some pie, or in both, and in spite of appropriate treatment, the cases having been correctly diagnosed ante-mortem by Dr. T. J. Conley, the servant died in twelve hours and the father in twenty-four. In both these cases the changes differed considerably from the previous, hence a brief description of the autopsy of the servant will be permitted.

It was made ten hours *post-mortem*.

The body was well nourished, muscular, about thirty-five years old; there were no external marks of violence; the peritoneal cavity was empty and the peritoneum normal; the stomach was somewhat dilated and hanging low down, it contained twenty ounces of greyish granular fluid, the mucous membrane was very much swollen, covered with large flakes of viscid mucus, its tissue was the seat of innumerable hemorrhagic areas occurring singly and in crops.

The hemorrhages occupy the summit of the folds as well as the depressions between them; the submucosa is swollen also and distended with clear fluid; the contents of the duodenum are watery, its mucous and submucous coat are greatly swollen, and here and there are occasional hemorrhages. The jejeunum and ileum contain about eighteen ounces of faintly yellowish fluid which looks like rice water;

the swelling diminishes from above downward, while the solitary and agminate follicles are considerably enlarged near the ileocæcal valve. The mucous membrane of the large intestine is pale, not much swollen, covered with strands of mucus, the contents rice water like.

The mesenteric glands are swollen, the liver shows indications of cloudy swelling; the kidneys seem normal; the respiratory organs and the upper parts of the intestinal tract are intact. The heart shows nothing abnormal, and the brain and its membranes show no structural changes.

Arsenic in abundant quantities was demonstrated by Prof. Haines in the gastro-intestinal contents, and in the liver and the kidneys. To recapitulate: In this case the changes consisted of acute catarrh of the stomach and the small intestine, with œdema of the gastric and duodenal submucosa, submucous hemorrhages, follicular swelling of the small intestine, acute catarrh of the large intestine, with a commencing parenchymatous degeneration of the liver.

CASE III.—SUICIDAL PARIS GREEN POISONING.

An old man swallowed a quantity of Paris green and died in about ten hours. Autopsy ten hours later.

Lips livid, skin over face pale, mouth and œsophagus normal, mucous membrane of pharynx is swollen and quite red. The stomach is considerably dilated with gas and fluid of a bluish or greenish tint, upon the inner surface are masses of mucus with green particles in it; the mucosa is greatly swollen and thrown into numerous folds; in it are numerous hemorrhages, the free surface of which appears eroded.

The contents of the small intestine show particles of green throughout the entire extent; the mucosa is much swollen; in some places opaque areas of varying size and form with slight superficial loss of substance can be observed, one of these areas is about three inches long, but does not include in all its parts the entire mucous membrane; in some parts there are fine hemorrhages in the vicinity of these areas, and there is a quite general capillary hyperæmia, the solitary glands are markedly prominent, but the increase in the Peyer's patches is not so marked. In the cæcum the poison is microscopically visible but not any further into the large intestine, the mucous membrane of which is pale and free from corrosion.

The liver measures 25x18x16x6½x3½ ctm.; it is very flabby, the capsule is smooth; the parenchyma is brownish in color with yellow spots and the lobules are enlarged with indistinct outlines and a con-

gested centre. The kidneys are of about normal size, in the cortex are found numerous pin head size hemorrhages; the mucous membrane of the ureters and of the bladder is swollen and shows a few ecchymoses.

The myocardium is opaque yellowish red and underneath the endocardium of the left ventricle are many extravasations.

The lungs and pleuræ are quite normal, ditto brain.

Recapitulation: Acute gastro-intestinal catarrh with hemorrhagic erosinous and capillary hyperæma; cloudy swelling of liver, acute parenchymatous nephritis with swelling of and extravasation into ureteral and vesical mucous membranes, acute parenchymatous myocarditis, subendocardial extravasation.

If we now pass in brief review the various changes that may be produced by arsenic, it will at once become very evident that they are exceedingly fitful and freakish, subject to marked variation in intensity and extent, not bearing a constant relation to the quantity introduced, nor to the time elapsing between the ingestion and the fatal end, so that a general description of all the changes that may be produced would rarely apply to a single concrete case.

Commencing with the mouth and the upper part of the digestive tract it may be said as a general rule that arsenic does not produce any changes upon the mucous membrane of the pharynx and œsophagus, when taken in its usual forms, although Woodman and Tidy* state that congestion of the gullet, mouth and windpipe from the application of the poison during vomiting, is general.

Externally the stomach and intestines do not usually present any changes although it is common to find the stomach somewhat dilated with gas and fluid, but the serous surface is almost always smooth and shining while the amount of blood in the subserous veins may vary within wide limits; the authors just quoted state that inflammation of the peritoneum is occasionally found, but, except in very rare cases, where it is secondary to perforation of the stomach this does not seem to have been described by other reliable observers. The contents of the stomach are usually a little bloody with considerable adherent viscid mucus; the mucous membrane is usually swollen, in some places it may be markedly opaque and greyish yellow in color, the epithelial cells under the microscope showing typical parenchymatous degeneration; at times it may be the seat of areas of capillary injection and hemorrhages, especially in the cardiac and pyloric regions and small areas of necrosis may be observed on the surface of the hemorrhagic district; then there may be croupous areas, that is,

*Forensic Medicine and Toxicology, Philad., 1887.

places covered with a more or less easily removable grayish membrane which microscopically shows a fibrinous network entangling mucus corpuscles, epithelial and round cells and often octohedral crystals of arsenic; the submucosa may be doubly thickened from œdema; perforation and gangrene are very rare occurrences, but cases are stated to be on record. Similar processes may continue into the duodenum and a considerable distance into the small intestine; usually the contents of the small intestine are rice-water like, the mucous membrane may show catarrhal enteritis, areas of croupous inflammation together with hemorrhages, districts of capillary hyperæmia and areas of necrosis and erosion, the follicles, solitary and agminate glands may be, and very frequently are, enlarged either from œdema or from cell multiplication.

The mucous membrane of the large intestine is also often the seat of a catarrhal or follicular enteritis with swelling of the mucosa and the production of viscid mucus; octahedrals may be found microscopically, and Woodman and Tidy* state that the rectum is invariably the seat of an acute inflammation, a statement that seems to me to be too sweeping.

Simple hyperæmia of the intestinal and gastric mucous membrane is exactly similar in appearance whether it owes its existence to physiological or to pathological conditions. The differentiation will depend upon the nature of the secretion and upon the appearance of the interstitial tissue and the lymphatic apparatus.

Acute gastric catarrh is always accompanied by the production of a viscid glairy, clear mucus; acute intestinal catarrh results in the outpouring of a considerable amount of watery fluid, an acute catarrh of the large intestine on the other hand, again leads to the production of mucus. If a few hours pass between the commencement of the inflammation and death and especially if the irritant be of some intensity, it nearly always leads to inflammatory œdema of the mucosa and submucosa and to considerable increase in the size of the regional lymphatic glands.

The hemorrhages and the hemorrhagic erosions will be more marked in cases of severe and prolonged vomiting and in cases of poisoning with arsenic in a solid form. The hemorrhagic necrosis is probably in part due to the production of capillary thrombosis as shown by Silbermann;† from its point of arrest in the stomach or intestine arsenic is absorbed into the capillaries and lymphatics; here it causes thrombosis in the vessels and a consecutive hemorrhagic necro-

*Loc. Cit.

†Virchow's Archiv, Band 117.

sis may follow, the tissue succumbing completely to the action of the gastric juice and to the attack of intestinal microbes.

The croupous exudate seems to be formed only where solid arsenic has been taken. Lesser* states expressly that he has never observed it except in such instances but not invariably even then; this is a point of some practical importance. The mesenteric glands are usually swollen red and soft partaking of the general regional lymphatic enlargement. Cloudy swelling and fatty degeneration are found frequently in the liver, though Woodman and Tidy† state that no *post-mortem* appearances are found in this organ, but Lesser† and Casper† have observed such changes in 18, in 9 and 7 hours, the liver being flabby, increased perhaps in size, the parenchyma being opaque and brownish with yellow areas, enlarged lobules with indistinct outlines, congested centres and pale cortical zones; microscopically the cells are large and granular with indistinct nuclei, acetic acid may dissolve some of the granules and boiling alcohol and ether others. According to Ziegler‡ various poisons such as phosphorus, arsenic and the ferments which produce fever, may like imperfect oxygenation, lead to disintegration of the albumen of the tissues and so to fatty degeneration.

The kidneys may show no changes at all or they may be the seat of parenchymatous degeneration and small cortical hemorrhages, the urinary sediment corresponding exactly to that in acute nephritis generally; the urethral and vesical mucous membrane may also be swollen and show hemorrhagic extravasations in occasional instances. The heart is often the seat of a parenchymatous myocarditis, especially the muscles of the left ventricle which are soft and flabby in consistence, greyish yellow in color on the cut surface and under the endocardium of the papillary muscles, the microscope showing typical cloudy swelling in the muscle fibres with even areas of fatty degeneration.

Underneath the endocardium, especially if not exclusively, in the left ventricle, are very frequently found small irregular shaped but typical areas of hemorrhagic extravasation, similar to those observed in cases of asphyxia. Any changes in the lungs directly referable to the action of arsenic cannot be said to occur except that sub-pleural hemorrhages are found quite often. The brain and spinal cord and their membranes are usually negative on macroscopical examination although the arsenic accumulates in them in greater quantities than in the other tissues of the body. In the peripheral nerves arsenic produces

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* Atlas der Gerichtlichen Medicin, Berlin, 1883.

† Loc. Cit.

‡ Ziegler, Pathological Anatomy and Pathogenesis, 1887.

well marked microscopic changes, the consideration of which would be out of place at the present time. The blood is stated to be dark in color and to coagulate feebly and imperfectly collecting in the heart and the large veins, no thick, firm and solid clots being formed. In connection with this it is interesting to note the experiments of Silbermann* who by means of injections of various poisonous substances, and among them arsenic into animals, came to the conclusion that many of the clinical phenomena and anatomical changes in arsenical intoxication are directly referable to the power of arsenic to cause a vascular dyscrasia resulting in primary capillary thrombosis with the formation of secondary stagnation thrombi; he observed the formation of capillary thrombi, autochthonous thrombi in smaller vessels, especially veins, and even in the heart, in animals who were injected with arsenical solutions and vivisected during the violent symptoms of poisoning that soon followed, arsenic acting as a typical blood poison. The occurrence of hæmo-globinuria after the inhalation of arseniuretted hydrogen shows what destructive action arsenic in this form may produce upon the red corpuscles and the occurence of thrombosis in the capillaries and larger vessels would certainly explain the hemorrhages some of the areas of necrosis and degeneration as well as many of the clinical symptoms observed in cases of arsenical poisoning. This phase of arsenical poisoning will undoubtedly be the subject of future and fruitful investigation. It at once suggests itself that the microscopic demonstration of capillary thrombosis in a suitable case of supposed arsenical poisoning would go far to settle the question of ante- or post-mortem introduction of the poison in case doubt should arise on this point.

119 Loomis St.

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* Virchow's Archiv. Band 117 Heft 2, Berlin, 1889